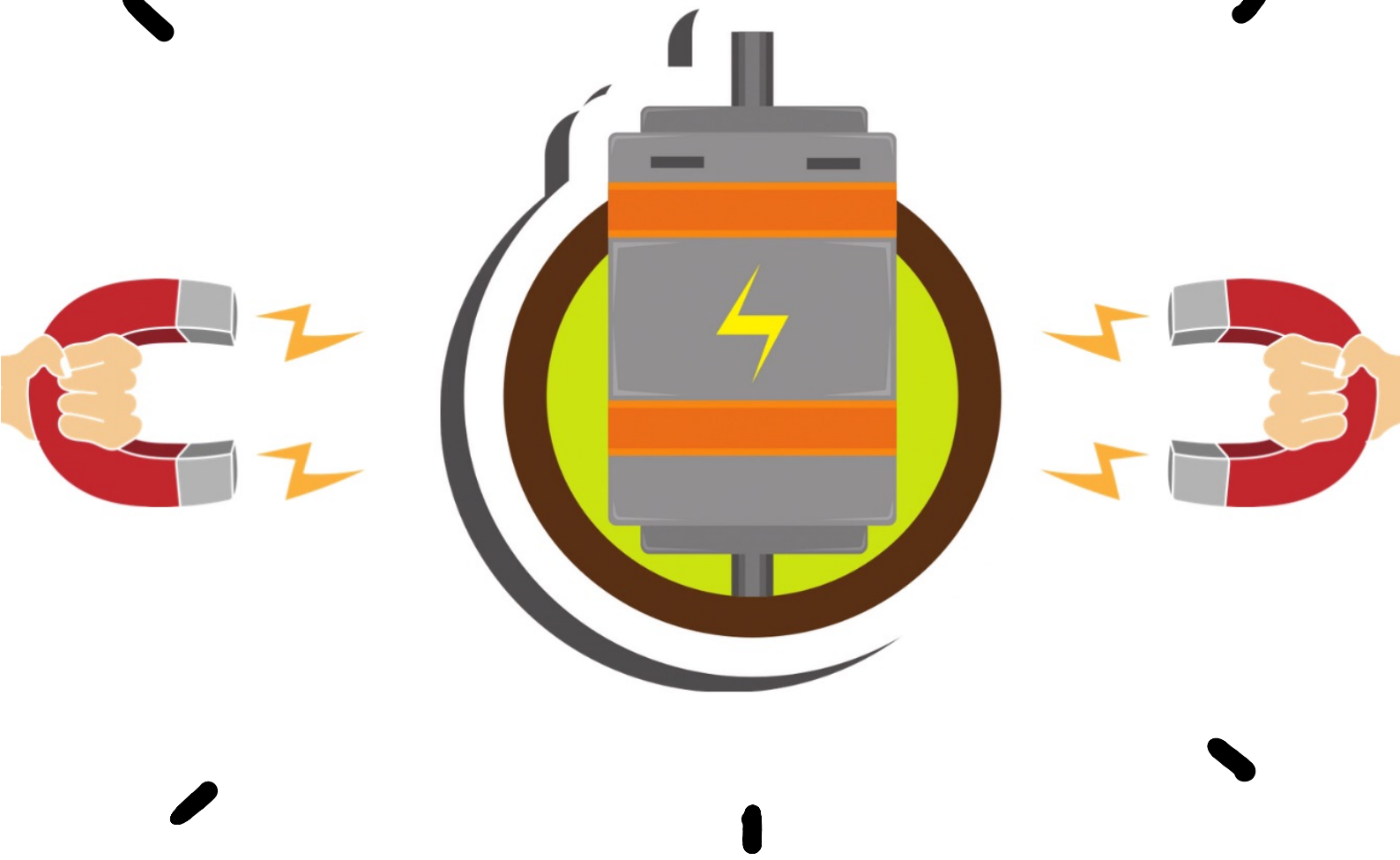
MAGNETIC EFFECTS

OF ELECTRIC CURRENT

HANDWRITTEN NOTES

[Prv. Years Included]



Designed With ♥

Shobhit Nirwan

Magnetic Effects of Electric Current

- Magnetic field and Magnetic field Lines
- Magnetic field due to current through a straight Conductor
  - Maxwell's Right hand thumb Rule
- Magnetic field due to current through circular loop
- Magnetic field due to current through solenoid.
  - Electromagnet
- Force on a current carrying conductor in a Magnetic field
  - Fleming's Left hand Rule
- Electric Motor
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- Electromagnetic Induction
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  - Ways to induce current in circuit
  - Fleming's Right hand rule

Hans Christian Oersted discovered that a compass needle got deflected when a current carrying metallic conductor is placed nearby it. According to him, deflection of compass needle was due to the magnetic field produced by electric current.

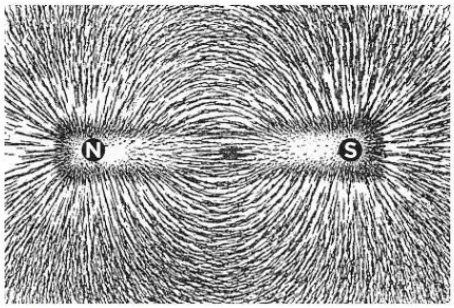
∴ Electric current through a metallic conductor produces a magnetic field around it.

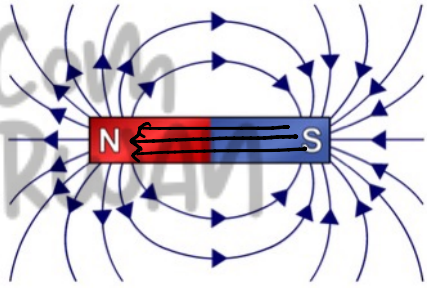
Magnetic Fields

↳ Space surrounding a magnet within which a magnetic force is experienced. It is a vector quantity. SI unit is tesla.

Magnetic Field Lines

↳ Imaginary lines used to represent magnetic field. When iron fillings are kept near a magnetic, they get arranged in a pattern which represents the magnetic field lines.

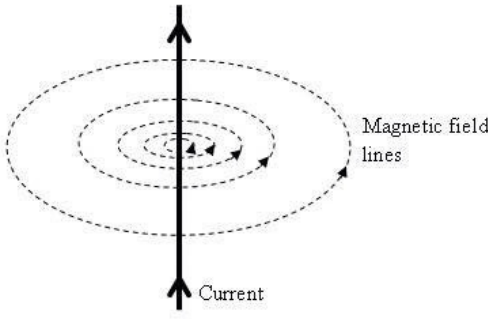




- They originate from North pole of a magnet and end at its south pole outside the magnet, but inside the magnet it is from south to north
- They are continuous and form closed curves.
- Tangent at any point on magnetic field gives the dirx" of magnetic field.
- Magnetic field lines never intersect each other.
- If field lines are close, field is stronger. If field lines are far apart, field is weak. → [cbse 2019]

Magnetic Field due to a Current through a Straight Conductor

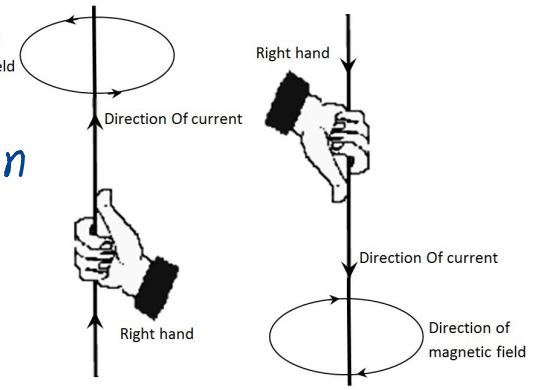
- Magnetic field lines are concentric circles with centre at wire.
- Magnitude of magnetic field increases if current is increased.
- Magnitude of magnetic field decreases if we move away from wire.



Maxwell's Right Hand Thumb Rule:

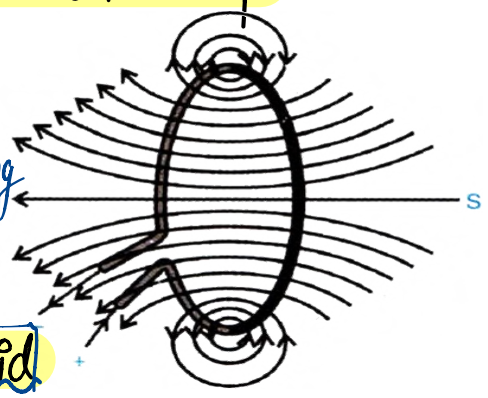
(Direction of Magnetic field निकालने के लिए।)

It states that, if you hold the current carrying straight wire in the grip of your right hand in such a way that stretched thumb points in direction of current, then the direction of the curl of the fingers will give the direction of magnetic field.



Magnetic field due to a current through circular loop

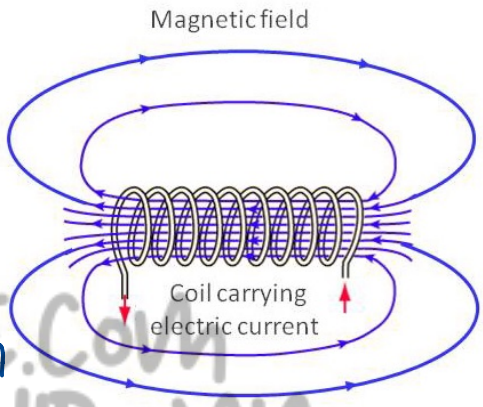
Here also we can use right hand thumb rule.
(because stright wire को ही तो circular बनाया है।)



- Strength of magnetic field can be increased by increasing the number of turns in the coil.
- Also, by increasing the current.

Magnetic Field due to Current in a Solenoid

- A coil of many circular turns of insulated copper wire wrapped closely in shape of cylinder.
- Magnetic field due to a current carrying solenoid is similar to that of that of magnetic field produced by a bar magnetic.
- Field lines inside the solenoid are parallel straight lines.



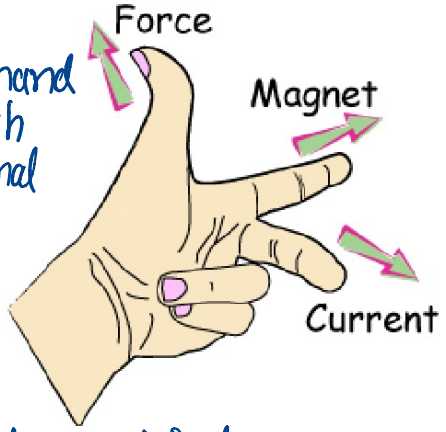
Electromagnet: A temporary magnet of soft iron core with a coil wound around it which retains magnetism only when current passes through the coil. It is used in electric bells, telephones, electric motor etc.

Force on a current Carrying Conductor in Magnetic Field

- If we place a current carrying conductor in a magnetic field then it experiences a force. (except placed parallel)
- Here we consider the direction of current and that of magnetic field is perpendicular to each other.
- It is due to the interaction between magnetic field produced by the current carrying conductor and external magnetic field in which conductor is placed.

Fleming's Left Hand Rule: [cbse 2020, 2019]

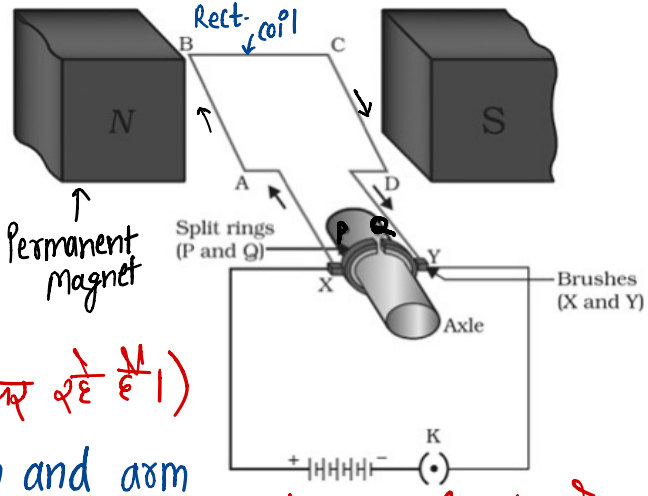
IF the forefinger, thumb and middle finger of left hand are stretched mutually perpendicular to each other, such that the forefinger points along the direction of external magnetic field, middle finger indicates the direction of current, then the thumb points towards the direction of force acting on the conductor.



Electric Motor [cbse 2019]

An electric motor is a rotating device that converts electrical energy to mechanical energy.

PRINCIPLE: force on current carrying conductor in a magnetic field.

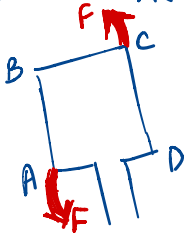


WORKING:

- Initially ABCD is in horizonal position.
- Key is closed, the current flows in ABCD
- As BC and AD are parallel ∴ No force acts on them.

(यहाँ पर हम उपर (force) वाले topic की बात कर रहे हैं।)

- AB experiences a force in downward direction and arm CD experiences an equal force in upward direction. (Fleming's left hand rule से direction निकाली।). This causes the coil to rotate in anti-clockwise direction.



- When coil rotates in vertical position, the brushes lose contact with the rings and current stops flowing. But the coil does not stop due to inertia of motion.
- When coil rotates, rings also change their positions and come in contact with opposite brushes.
- This reverses the direction of current through the coil but the direction of current on right hand side of coil remains the same.

So, the force on right hand side is always upward and a force on left hand side is always in downward direction. Thus, the coil continues to rotate in anti-clockwise direction.

Commercial uses of motor:

- Can be used as an electromagnet in place of permanent magnet.
- An armature, which is the assembly of soft iron core and coil.

Electromagnetic Induction (Discovered by Michael Faraday)

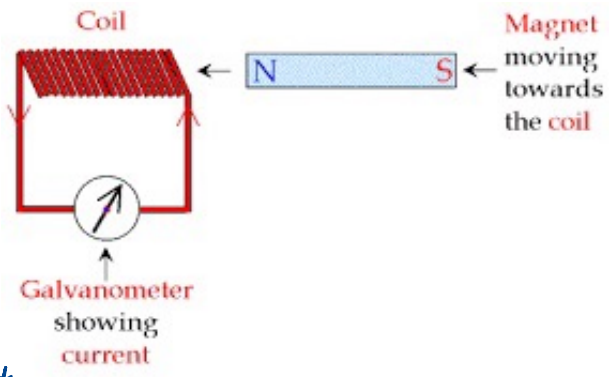
An electric current produced in a closed circuit by a changing magnetic field is called as induced current. This phenomenon is called Electromagnetic Induction.

↳ [cbse 2020]

 # Galvanometer: An instrument that can detect the presence of a current in a circuit. The pointer remains at zero (centre of the scale) for zero current flowing through it. It can deflect either to the left or to the right of the zero marks depending on the direction of current.

Ways to Induce Current in a Circuit :-

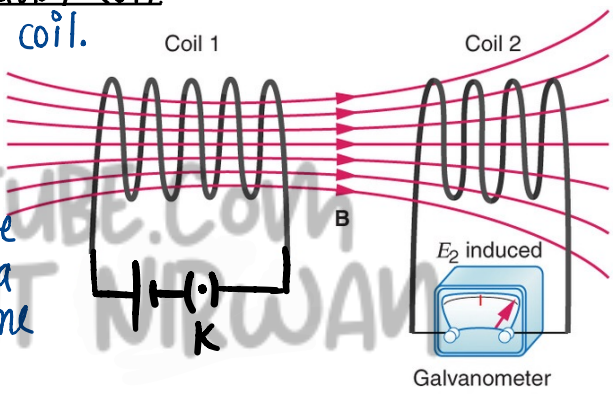
(I) By moving a coil in a magnetic field :



- Moving a coil towards a magnet sets up an electric current in the coil circuit as indicated by direction of galvanometer needle.
- The induced current is found to be maximum when the direction of motion of coil is at right angle to magnetic field.
- The direction of induced current can be reversed by reversing the direction of magnetic field. and if the coil as well as magnet are stationary, then no current is induced in the coil.

(II) By changing the magnetic field around a nearby coil :

Coil 1 is primary coil and coil 2 is secondary coil. Primary one is connected to a battery. When the key (K) is closed, the current in primary coil takes a little time to rise from zero to a maximum valve. This causes a momentary change in magnetic field around this coil. This induces a momentary current in the secondary coil. The same happens in the reverse direction when the key is opened. Current is induced in coil 2 when current in coil 1 is changed which is indicated by the deflection in galvanometer needle.



Fleming's Right Hand Rule : If forefinger, middle finger and thumb of the right hand are stretched at right angles to each other, with the forefinger in the direction of the motion of the wire, then the induced current in the wire is in the direction of middle finger.